MICROSTRUCTURE SENSITIVE DESIGN USING STATISTICAL CONTINUUM MECHANICS BASED ON TWO POINT CORRELATION FUNCTIONS

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Two-point distribution functions are used here to introduce "Microstructure Sensitive Design" in two-phase composites. Distribution functions are commonly used for the representation of microstructures and homogenization of materials properties. The use of two-point statistics allows the composite designer to include the morphology and distribution in addition to the properties of the individual phases and components. Statistical continuum mechanics is used to make a direct link between the microstructure and properties (elastic and plastic) in terms of these two point statistical functions. An empirical form of the two-point statistical function is used which allows the construction of a composite Hull. The Spectral form of the two-point function is examined and applied to two-phase composites. Two different composites (isotropic and anisotropic) are considered and the effect of anisotropy for the prediction of the elastic properties is discussed.

Recently a methodology was developed by Adams, et. al. (1) that uses a spectral representation as a tool to allow the mechanical design to take advantage of the microstructure as a continuous design variable. This new approach, called microstructure-sensitive design (MSD) uses a set of basis functions to represent the microstructure (e.g. single orientations) as a material set. MSD is presently taking advantage of "texture" in the form of Orientation Distribution Function the representation of polycrystalline materials (1). Orientation Distribution Function (ODF) is a one-point statistical distribution function that only considers volume fractions (or number fractions) of crystallites with the same orientation. Two point correlation functions provide information about near neighbor and far field effects and allow the defect sensitive properties to be incorporated in the analysis (2). The extension to higher order statistics adds a higher order of dimensionality in the Materials Hull. The composite formulation will be tremendously enhanced by the use of two point correlations (3). The prediction of mechanical property from the details of the microstructure such as phase, crystalline grain distribution and morphology has received a special attention in the mechanics and materials community (3).

References
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